



WATER RESOURCES RESEARCH GRANT PROPOSAL

Project ID: 2005AL37B

Title: Development and Application of an Innovative Nanotechnology for In-situ Remediation of Mercury-Contaminated Alabama Soils and Sediments

Project Type: Research

Focus Categories: Non Point Pollution, Sediments

Keywords: Fish poisoning, immobilization, mercury, methylmercury, nanoparticle, nanotechnology, remediation, sediment, water quality, wetland

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Congressional District: Third

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Abstract

Mercury is one of the most pervasive contaminants. The annual global input to the atmosphere is estimated to be 5,500-6,000 metric tons. The annual anthropogenic Hg emitted in the U.S. total 158 metric tons, of which approximately 33.3% is deposited in the homeland. In addition, the global reservoir adds approximately 35 tons of Hg annually to the U.S. territory. Mercury contamination is also growing. Since the industrial revolution, Hg content in the atmosphere has increased 200-500%. Hg in Atlantic Ocean water has been growing at 1.2~1.5% per year since 1970.

When Hg enters water or sediments, biological processes transform it to methylmercury (meHg), which is the most concerned form of Hg because of its ability to accumulate in the food web especially in fish and animals that eat fish. Over 95% Hg in fish is in MeHg. Since fish consumption is the most common pathway of human exposure to Hg,

MeHg is considered the most dangerous Hg species to human health. As of 2003, 45 states have issued ~3,089 fish consumption advisories, of which over 80% are, at least in part, associated with Hg poison. MeHg is a potent neurotoxin. Most at risk are children and the unborn. According to CDC, ~320,000 babies born annually in the U.S. are at risk for neuro-developmental delays. In wildlife, mercury is a reproductive hazard.

In recent years, MeHg at concentrations 10-20 times higher than the safe level of 0.5 ppb was widely detected in various popular fish such as largemouth bass in the estuaries near the Mobile Bay. The State of Alabama has issued Hg advisories, which essentially banned the consumption of fish in 17 south Alabama streams or bays. Hg testing of fish in other Gulf States revealed that many of the popular Gulf species contained so much Hg that FDA regulations would prohibit them from being sold. Because of Hg contamination, the Fish River in Weeks Bay watershed is included in the Clean Water Act 303(d) list.

Because of the pervasive nature of Hg contamination, it has been highly challenging to apply engineering approaches to mitigate the toxic effect of Hg. However, increasing evidence has indicated that the key to mitigate Hg poisoning is to control the Hg methylation, i.e. formation of MeHg. While total Hg can spread over a large area or region, Hg methylation is highly site-specific and depends on a number of environmental factors such as pH, redox potential, natural organic matter (NOM), and sulfur content. Therefore, the Hg toxicity can be controlled through engineering manipulation of Hg methylation, which is the strategy of this proposed research.